

The changing and unchanging aspects of the relationship with rising oil prices

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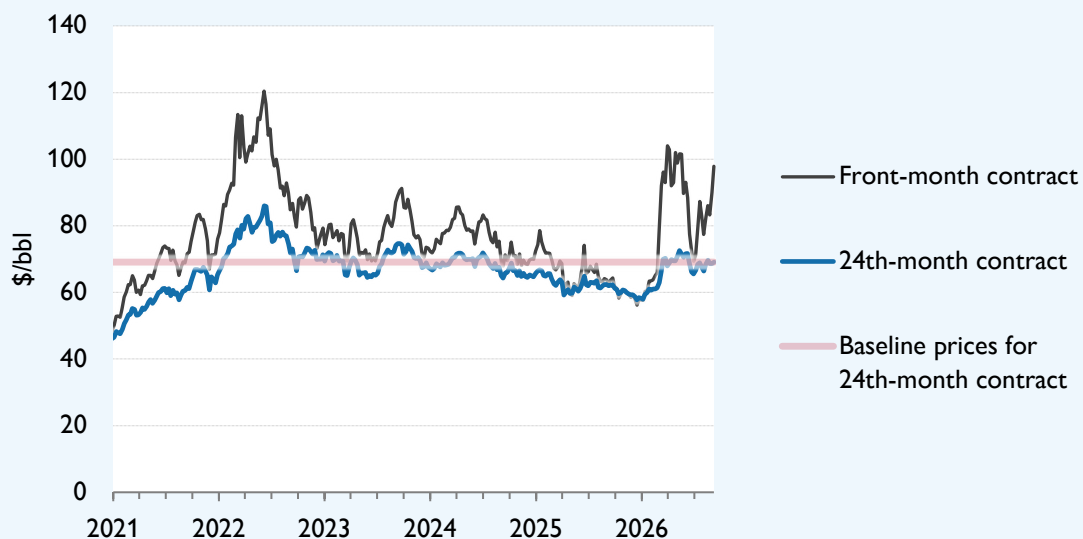
Summary

Crude oil prices soared following the attacks on Iran by the United States and Israel, which began in February 2026, and the subsequent blockade of the Strait of Hormuz. After a temporary dip, the prices are currently rising again following the resumption of attacks. Against this backdrop, a back spread—where the front-month contract is more expensive than forward-month contracts—has become pronounced.

When examining the quantitative relationship between the front-month futures prices of West Texas Intermediate (WTI) crude oil and its forward-month futures prices, it is evident—as one might intuitively expect—that the influence of the front-month futures price weakens for more distant forward-month futures prices. Whilst the link between front-month futures and forward-month futures tends to weaken during periods of rising crude oil prices, this trend is particularly pronounced at present.

Whilst it is not unexpected that crude oil price levels should alter the relationship between front-month and forward-month futures contracts, it is worth noting as a point of interest that these changes are not random but exhibit a consistent relationship. The ‘baseline price’ of WTI crude oil futures derived from this is approximately \$70/bbl for the 12th-, 24th- and 36th-month contracts. For Brent crude oil, this stands at around \$73/bbl, and the difference between the baseline prices of WTI and Brent crude oils broadly corresponds to the value widely recognised as the inter-crude oil price differential.

Figure 1 | WTI crude oil futures prices and their ‘baseline prices’

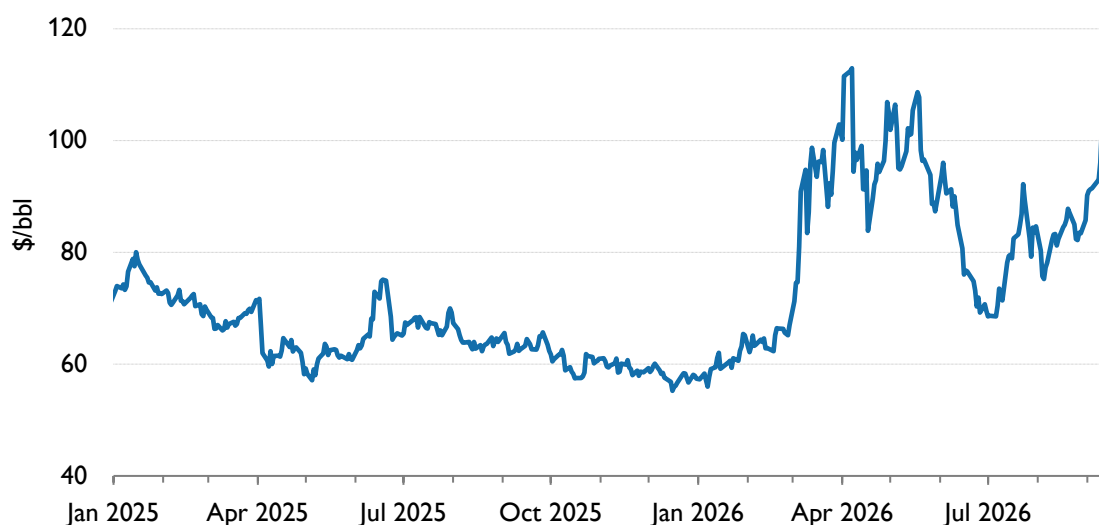


The significant back spread that has emerged as a result of the weakening link between front-month and forward-month contracts is a boon to financial investors employing a long-only strategy. Furthermore, the absence of strong bullish sentiment, which is not driving further price skyrocketing, offers a small measure of relief to oil consumers struggling with high oil prices. On the other hand, the market's signal that future oil prices are not expected to rise as sharply as front-month contracts suggest is likely to make crude oil suppliers hesitant to invest in increasing supply. Viewed through the lens of the futures market, it may be entirely natural that efforts to expand supply capacity have not yet gained significant momentum.

Crude oil prices rebound again

The attacks on Iran by the United States and Israel, which began in February 2026, and the subsequent blockade of the Strait of Hormuz caused the stable supply of oil to collapse, leading to a sharp rise in crude oil prices. The price of West Texas Intermediate (WTI) crude oil¹, the marker crude oil, had fallen below \$60 per barrel at the start of 2026, but then reversed course and rose sharply in March to exceed \$100/bbl. Subsequently, in late June, prices briefly fell below \$70/bbl following the signing of a memorandum of understanding between the United States and Iran aimed at ending the fighting. However, this was short-lived; against a backdrop of renewed concerns over the situation in the Middle East and the resumption of attacks, prices rebounded once more, breaking through the \$100/bbl mark in September (Figure 1).

Figure 2 | WTI crude oil prices



Note: Futures, front-month contract, settlement price

Source: Calculated from data by New York Mercantile Exchange

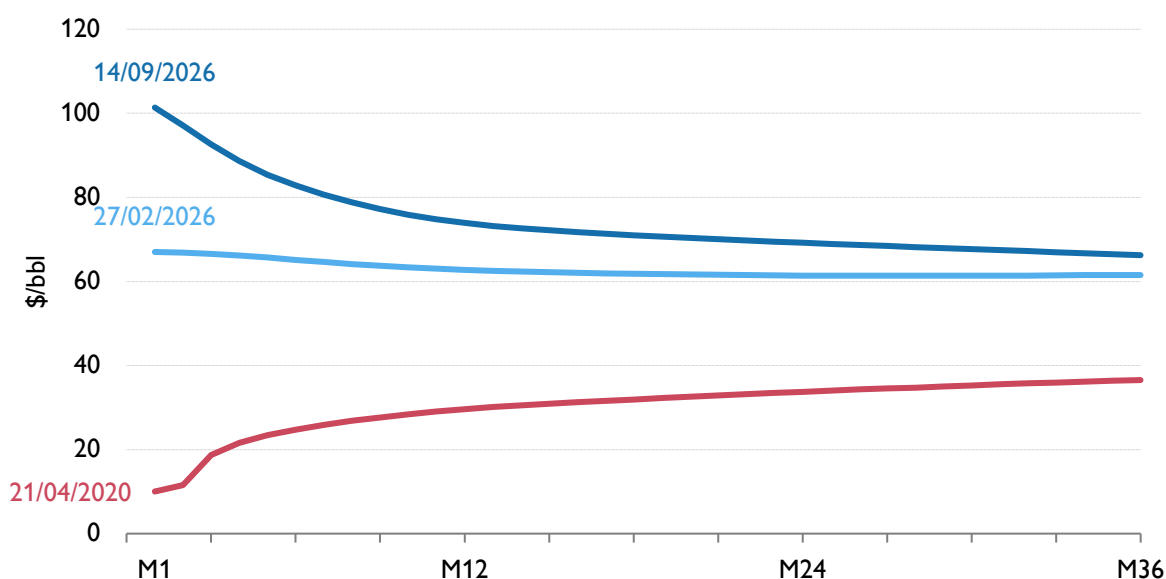
Forward-month futures prices are relatively low and stable.

When one speaks of 'oil prices', reference is often made to the price of the front-month contract (M1) for WTI (or Brent) crude oil futures. However, there are also futures contracts with delivery months further in the future (second month [M2], third month [M3], etc.), and prices are set for each of these. When these prices are arranged in order of delivery month, they are referred to as the futures curve (Figure 2). It is said that the futures curve reflects market participants' outlook for the future. Since the easing of the impact of the coronavirus disease (COVID-19), crude oil futures prices have, for the most part, been in a state of 'backwardation', where the front-month contract is higher and prices fall as the delivery month moves further into the future². The current situation is no exception to this pattern, although the slope of the futures curve has become steeper.

¹ Futures, front-month contract, settlement price

² Depending on the period, a 'contango' may develop, with prices rising the further out the delivery month is. Furthermore, the typical shape of the futures curve varies depending on the underlying asset.

Figure 3 | WTI crude oil futures curves

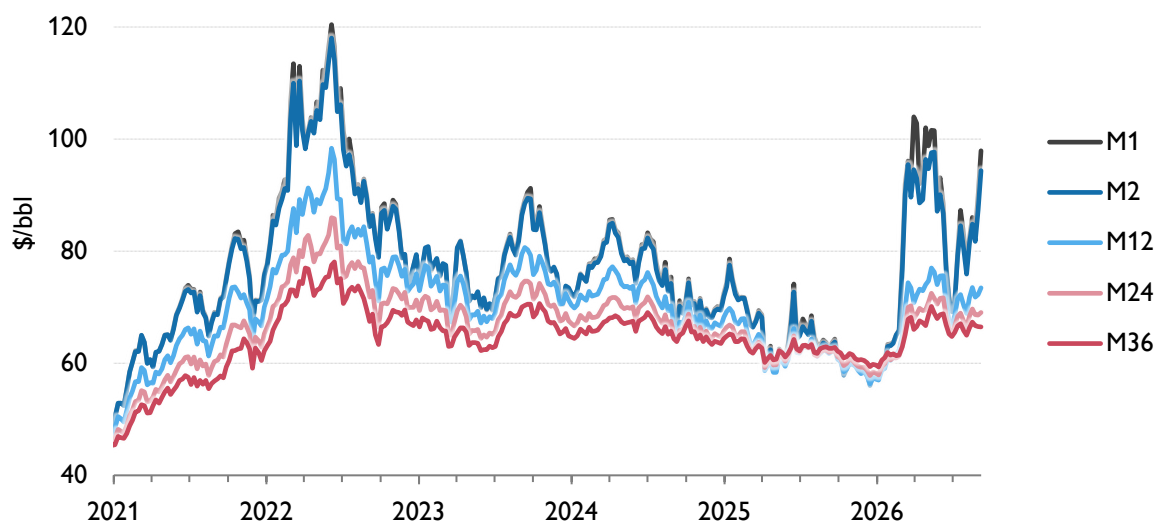


Note: Settlement prices

Source: New York Mercantile Exchange

However, the fact that forward-month futures are cheaper is strictly a matter of comparison with front-month futures. If one compares each forward-month futures at different points in time, there are naturally periods when they are expensive and periods when they are cheap (Figure 3). Furthermore, whilst the price changes of forward-month futures often resemble those of front-month futures, their amplitude varies considerably depending on the specific delivery month, tending to be smaller the further the delivery month is from the front-month contract (Figure 4). Differences in the outlook until each delivery month, amongst other factors, underpin these price differentials and changes through variations in the balance between long and short positions for each contract.

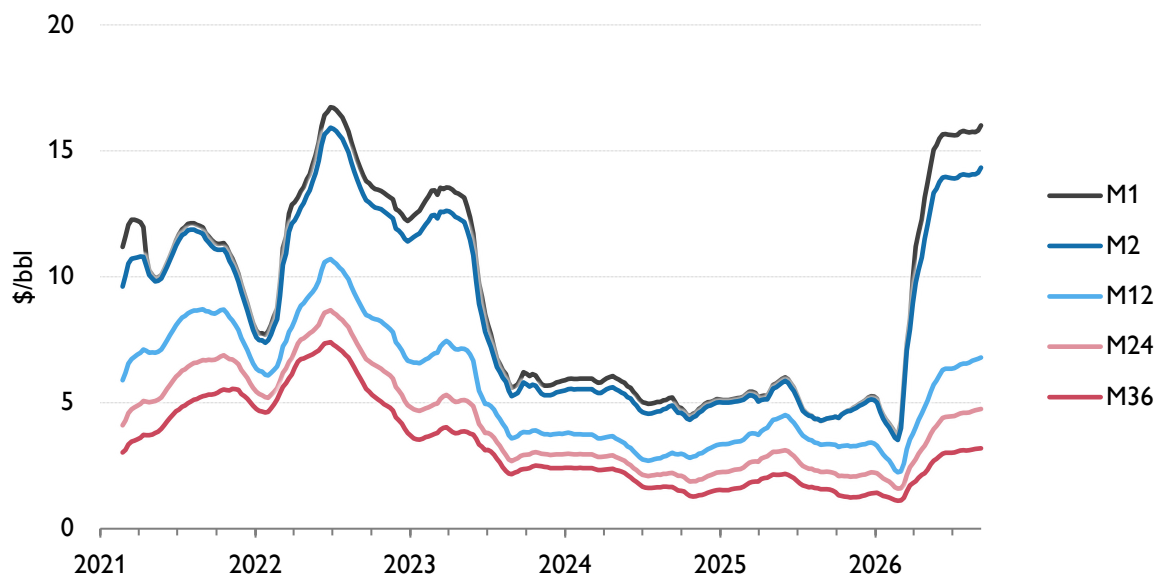
Figure 4 | WTI crude oil futures prices



Note: Settlement prices, weekly average

Source: Calculated from data by New York Mercantile Exchange

Figure 5 | Historical volatility of WTI crude oil futures prices



Note: Settlement prices, weekly average prices, 52-week moving standard deviation

Source: Calculated from data by New York Mercantile Exchange

The medium-term equilibrium relationship between front- and forward-month futures prices

The influence of front-month futures price is weaker for more distant forward-month futures prices.

This study aims to elucidate the quantitative relationship between the front-month futures price (M1) of WTI crude oil and the prices of its forward-month futures (the second month [M2], the 12th month [M12], the 24th month [M24] and the 36th month [M36]). Assuming the relationship described by Equation (1)—which provides a clear outlook—based on weekly average prices, we estimated the parameters c_0 and c_1 by dividing the period into segments from the time the impact of COVID-19 began to subside up to the present^{3, 4}:

$$M_x = c_0 + c_1 \times M1 + u \quad (x = 2, 12, 24, 36). \quad (1)$$

Where u is the disturbance term.

The constant term c_0 obtained is positive regardless of the period or contract (Figure 5, left). This is the case even though, for most periods during the analysis period, forward-month futures were cheaper than front-month futures—a state of backwardation. Consequently, it is not particularly appropriate to assess the prices of more distant forward-

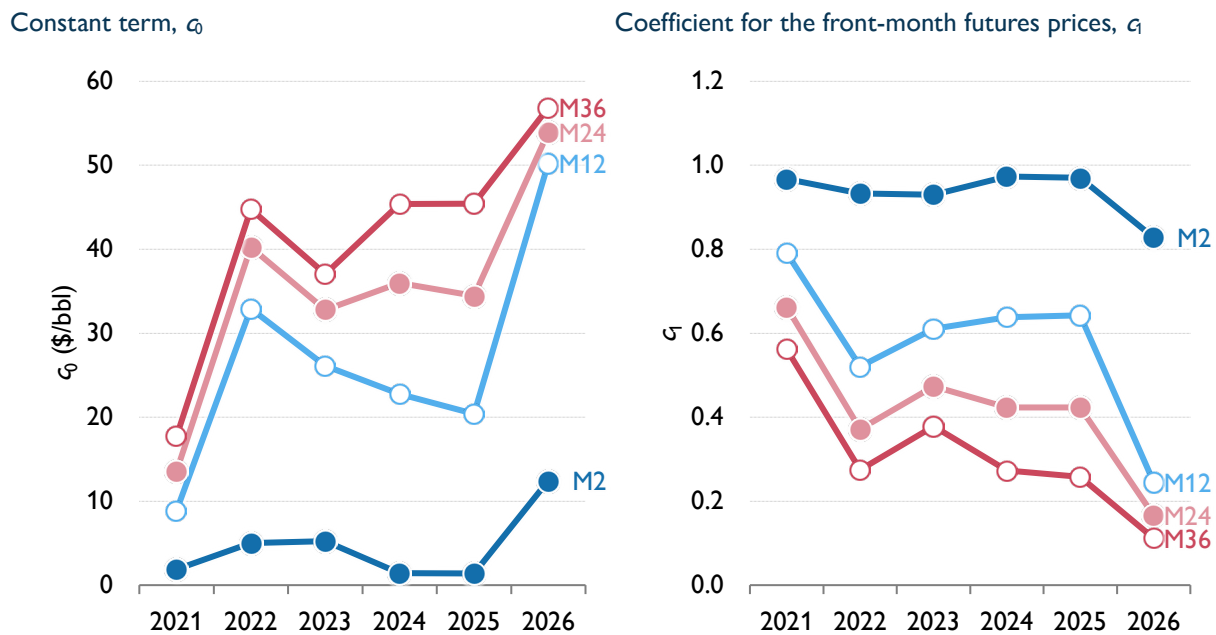
³ As a general rule, the periods were defined in calendar years. Specifically, 2021 = the week of 28 December 2020 to the week of 27 December 2021; 2022 = the week of 27 December 2021 to the week of 26 December 2022; 2023 = the week of 26 December 2022 to the week of 25 December 2023; 2024 = the week of 1 January 2024 to the week of 30 December 2024; 2025 = the week of 30 December 2024 to the week of 23 February 2026; and 2026 = the week of 23 February 2026 to the week of 7 September 2026. The decision to set the boundary between 2025 and 2026 as the week of 23 February 2026 was an exception, due to the significant impact that the attack on Iran had on oil prices.

⁴ Although it is suspected that the WTI crude oil futures prices under consideration are all first-order integrations, it is estimated that the prices of the forward- and front-month futures are in a first-order cointegration relationship, as will be discussed later (with the exception of the second-month futures in 2025). Consequently, regression analysis between the price levels is not subject to the adverse effects of spurious correlation.

month futures (the 12th-, 24th- and 36th-month contracts), for which the constant term c_0 takes on large values, by applying a discount relative to the front-month futures price, such as ‘front-month futures price – X (\$/bbl)’.

To reinforce this, or as part of the same phenomenon, in the case of more distant futures contracts, the coefficient c_1 for the front-month futures price falls well below 1 (Figure 5, right). Whilst the front-month futures price does influence the price of forward-month futures prices, the extent of this influence becomes less pronounced as the delivery month moves further into the future, to the point where it can hardly be described as dominant.

Figure 6 | Parameters describing the relationship between WTI crude oil forward- and front-month futures prices



Changing relationships and unchanging relationships

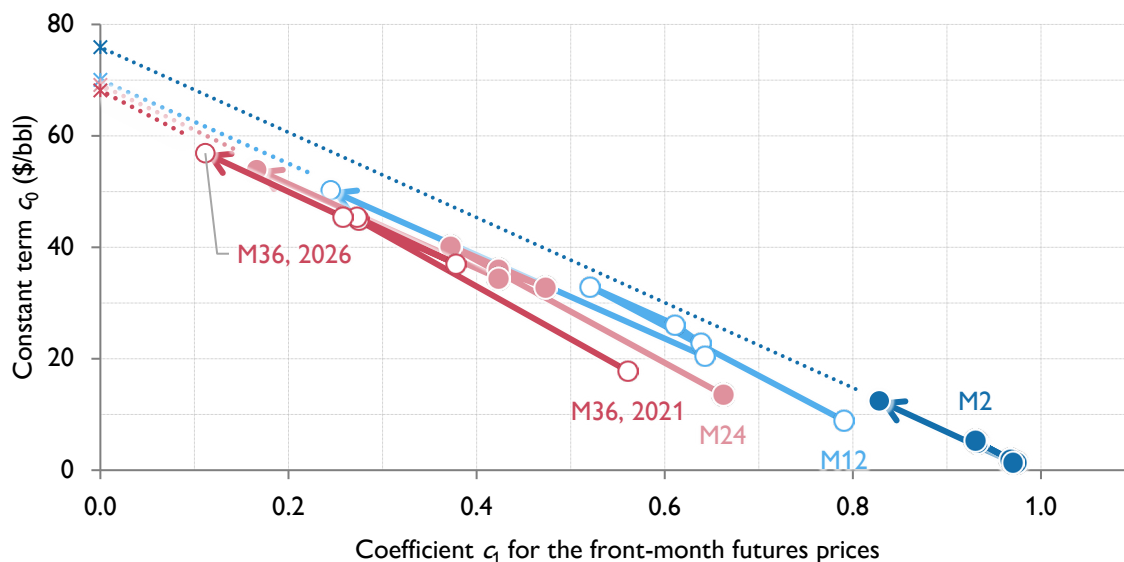
As can be readily seen from Figure 5, these parameters vary over time. In summary, the coefficient c_1 for the front-month futures prices (M1) shows a decline during periods of rising crude oil prices, such as in 2022 and 2026. This reflects the fact that front-month futures prices reached exceptionally high levels. It is highly likely that the market interpreted the surge in oil prices following the COVID-19 pandemic as being driven by the impact of temporary, short-term events, rather than by structural, medium- to long-term tightness in the supply and demand balance for oil. This is consistent with the frequently cited interpretation that many ‘events’ are expected to be resolved or alleviated within a relatively short timeframe, will not lead to supply-demand tightness in the distant future, and therefore do not exert significant upward pressure on forward-month futures prices—hence, a sharp rise in the front-month futures prices lead to the emergence of a steep backwardation⁵. Conversely, during periods when oil prices were low, such as in 2021 and 2025, the coefficient c_1 for the front-month futures prices took on a high value, suggesting a strong link between the front- and forward-month contracts.

This relationship between crude oil prices and changes in the parameters (and, by extension, the futures curve) is, to some extent, a result that might be intuitively anticipated. However, it is worth noting as a point of interest that the manner in which the parameters change is not random but rather exhibits a consistent relationship. Specifically, it appears that the sum of the constant term c_0 and the coefficient c_1 for front-month futures prices remains approximately constant for all contracts, regardless of the period (as indicated by the downward-sloping straight line in Figure 6). If this is the case, the value of c_0 when the influence of the front-month futures prices is eliminated (i.e.

⁵ The emergence of contango during a sharp fall in oil prices can also be explained in the same way.

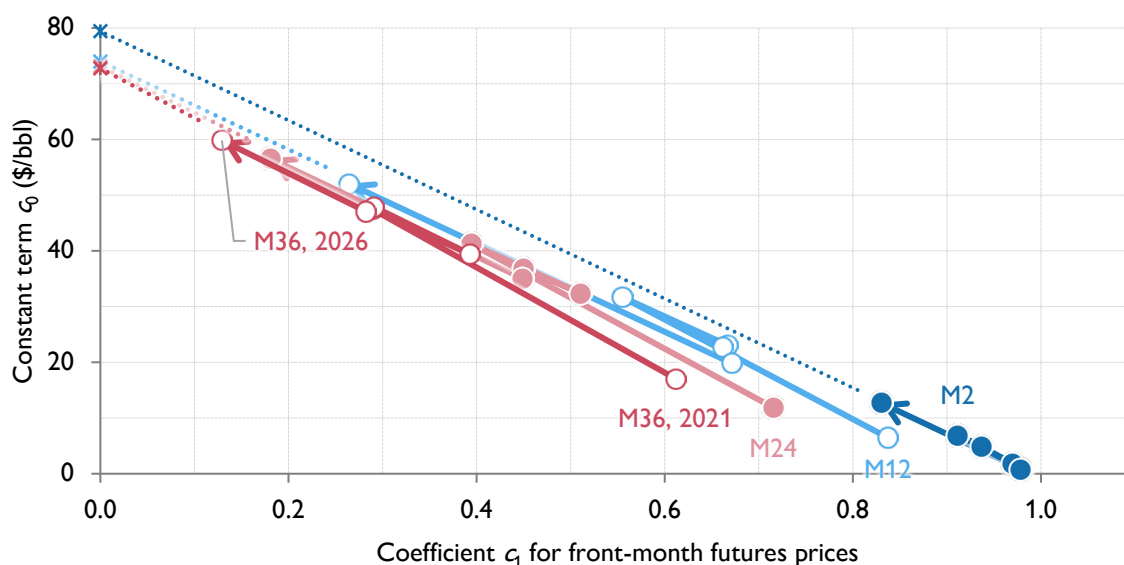
when c_1 is extrapolated to 0) can be interpreted as representing the baseline price for each contract. This value is approximately \$70/bbl for the 12th-month contract (M12), the 24th-month contract (M24) and the 36th-month contract (M36) (the second-month contract [M2], whose delivery month is closest to the front-month contract among the forward-month contracts, is slightly higher at around \$75/bbl). When it comes to more distant futures prices, the figure of around \$70/bbl may be tacitly recognised by market participants as a kind of benchmark.

Figure 7 | Parameters describing the relationship between WTI crude oil forward- and front-month futures prices



This relationship between the parameters is observed not only in WTI crude oil but also in Brent crude oil, another marker crude oil (Figure 5). Furthermore, the baseline prices for the Brent crude oil 12th-, 24th- and 36th-month futures contracts, derived in the same manner, are all around \$73/bbl (the second-month futures contract is around \$79/bbl). The difference between the baseline prices of WTI and Brent crude oils is broadly consistent with the widely recognised inter-crude oil price differential, which reflects infrastructure constraints.

Figure 8 | Parameters describing the relationship between Brent crude oil forward- and front-month futures prices



The short-term relationship between front- and forward-month futures price changes

What we have been discussing so far is, according to the error correction model, the medium-term equilibrium relationship. In the short term, however, forward-month futures prices may deviate from this equilibrium relationship. In order to quantitatively clarify the relationship between the changes in forward-month futures prices (the second-month contract [M2], the 12th-month contract [M12], the 24th-month contract [M24] and the 36th-month contract [M36]) for WTI crude oil and the changes in the front-month futures price (M1), we assumed an error-correction model of the form shown in Equation (2), with the week-on-week change (difference, Δ) as the basic form, and estimated the parameters^{6, 7}:

$$\Delta Mx = d_{10} \times \Delta M1 + d_{11} \times \Delta M1_{-1} + d_{21} \times \Delta Mx_{-1} + d_{22} \times \Delta Mx_{-2} + d_3 \times ECT_{-1} + v \quad (x = 2, 12, 24, 36). \quad (2)$$

Where ECT is the error correction term representing the residual in Equation (1), v is the disturbance term, and the subscript $_{-1}$ refers to the previous week's value.

Following the US and Israeli attacks on Iran that began in February 2026, the coefficient d_{10} for the changes in front-month futures prices $\Delta M1$ has decreased (Figure 8, left). In other words, the influence of changes in front-month futures prices on changes in forward-month futures prices ΔMx at the same point in time has weakened. Consequently, although the range of front-month futures price changes has widened sharply recently, the magnitude of their contribution to more distant futures contracts (the 12th-, 24th- and 36th-month contracts), where the decline in d_{10} has been particularly pronounced, has in fact diminished (Figure 8, right). The weakening of the link between front-month and forward-month futures, as revealed in the medium-term equilibrium relationship, is also evident in short-term changes.

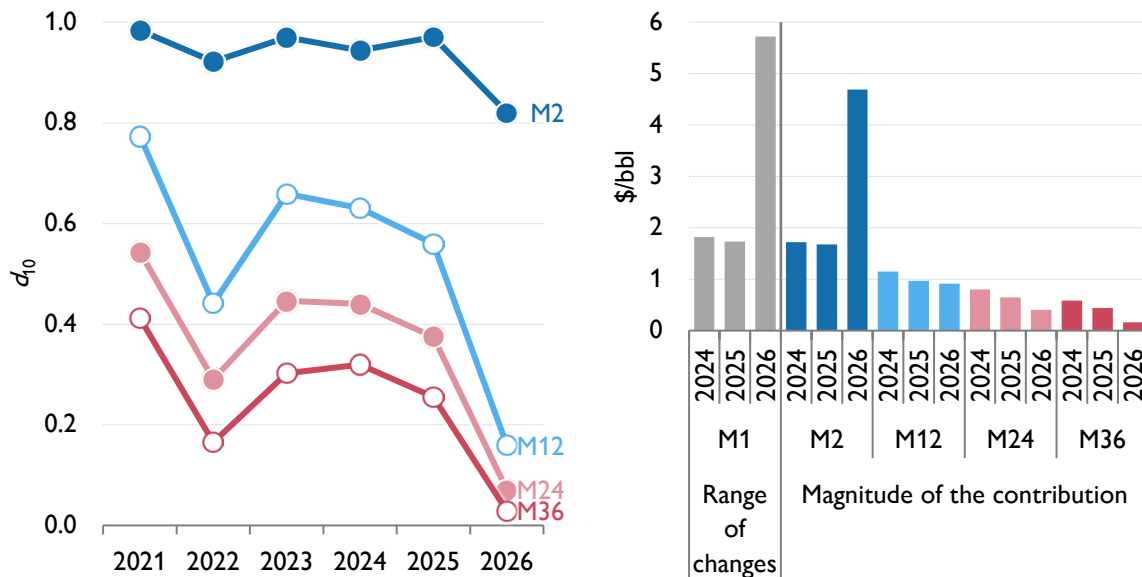
⁶ In other words, it is assumed that when a deviation from the medium-term equilibrium occurs, an adjustment mechanism comes into play to correct that deviation. However, based on the results of the augmented Dickey–Fuller test, the second-month futures in 2025 were not treated as an error-correction model.

⁷ Based on the results of the regression analysis, some terms were deemed unnecessary.

Figure 9 | The relationship between the price changes for WTI crude oil futures for the second-month contract, the 12th-month contract, the 24th-month contract and the 36th-month contract, and the price changes for the front-month contract

Coefficient for changes in front-month futures prices, d_{10}

The range of price changes in front-month futures and their contribution to price changes in forward-month futures contracts



Note: The range of changes is the period average of $|\Delta M1|$, and the magnitude of the contribution is the period average of $d_{10} \times |\Delta M1|$.

The weakening of the link between front-month and forward-month futures contracts may...

The price of the front-month futures contract—commonly referred to as the ‘oil price’—has not yet reached the levels seen in 2022, when the Russian invasion of Ukraine began, but its changes are currently more pronounced than at that time. Against this backdrop, the links between the front-month and forward-month futures contracts have weakened compared with 2022, both in terms of price levels and changes.

The resulting pronounced backwardation has become a source of substantial profits from rollovers as futures contracts approach their settlement dates, which may prove beneficial for financial investors employing a ‘buy-and-hold’ (long-only) strategy. Furthermore, the absence of strong bullish sentiment, which is not driving further price skyrocketing, offers a small measure of relief to oil consumers struggling with high oil prices.

On the other hand, the market’s message—that future crude oil prices are not expected to rise as sharply as seen in the front-month futures—is likely to make crude oil suppliers hesitant to invest in increasing supply. Oil prices remain at historically high levels, having lost the downward pressure that had been anticipated against the backdrop of forecasts of a supply surplus circulating prior to the US and Israeli attacks on Iran. Nevertheless, the fact that moves towards expanding supply capacity have not become particularly active may be a perfectly natural state of affairs when viewed through the lens of the futures market.

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